Claims

1.   A method of synthesising electrocardiographic (ECG) signals by receiving
signals from a first group of electrodes connected to predetermined locations on a
human body to acquire a first set of ECG signals and deriving at least one further ECG
signal using predetermined transformation(s) on said first set of ECG signals or a
subset thereof to form a desired set of signals, wherein the first group of electrodes
comprises the standard 12 lead electrode sites V2 and V5 plus at least one electrode
positioned substantially level with V5 on the right anterior auxiliary line, and at least
one further electrode positioned on each of the right hand side and left hand side of the
body

2.   A method as claimed in claim 1 wherein the electrode sites are located at:
        V2: the standard 12 lead electrode site V2;
        V5: the standard 12 lead electrode site V5;
        V5R: level with V5 on the right anterior auxiliary line;
        RA: the standard 12 lead electrode site RA (arm, shoulder, wrist or hand); and
        LA: the standard 12 lead electrode site LA (arm, shoulder, wrist or hand).

3.   The method of claim 1, wherein said further electrodes on the right hand side
and left hand side of the body are placed on the torso substantially level with the upper
portion of the limbs.

4.   A method as claimed in claim 1 or 3 wherein the electrode sites are located at:
        V2: the standard 12 lead electrode site V2;
        V5: the standard 12 lead electrode site V5;
        V5R: level with V5 on the right anterior auxiliary line;
        R: anywhere in the region of the right hand side of the body, between the front
        upper chest above the level of the heart and the right arm, shoulder or hand; and
        L: anywhere in the region of the left hand side of the body, between the front
        upper chest above the level of the heart and the left arm, shoulder or hand.

5.   A method as claimed in claim 3 wherein the electrode sites are located at:

V2: the standard 12 lead electrode site V2;

V5: the standard 12 lead electrode site V5;

5   V5R: level with V5 on the right anterior auxiliary line;

RC: on the upper chest of the body, at the same height as the manubrium and on the right mid-clavicle line; and

LC: on the upper chest of the body, at the same height as the manubrium and on the left mid-clavicle line.

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6.   A method for obtaining a set of ECG signals as claimed in any preceding claim wherein the electrode position V2 is replaced by an electrode position Vc which is defined to be on the sternum directly between the standard electrode sites V1 and V2.

15   7.   The method as claimed in any preceding claim, further including deriving an ECG signal from a temporary electrode that is not connected for the full duration the ECG measurement.

8.   The method as claimed in claim7, further comprising generating a subject-
20   specific transformation or set of transformations acting on the ECG signals to synthesise a representation of the temporary electrode signal after disconnection of the temporary electrode.

9.   The method of claim 7 or 8 wherein the temporary electrode is reactivated or
25   reapplied at a later time in order to redefine the subject-specific transformations.

10.   The method of any of claims 7, 8 and 9 further including defining a reference potential for each temporary electrode from one of the following options: the electrical potential of an ECG electrode; the electrical potential of a different temporary electrode
30   or a potential formed by a combination of ECG electrode(s) and/or temporary electrode(s).

11.   The method of any of claims 7 to 10 wherein a temporary ECG signal is defined as the potential difference between the potential at the temporary electrode and its reference potential.

5   12.   The method as claimed in any of claims 7 to 11 further comprising obtaining a set of ECG signals from both the first set of ECG signals and the temporary electrode signal.

13.   A method as claimed in claim 12 wherein the temporary signal(s) is synthesised
10   using subject-specific transformations on the second set of ECG signals.

14.   The method as claimed in any of claims 7 to 13 further comprising obtaining a second set of ECG signals from the subject using just the first group of electrodes.

15   15.   A method as claimed in any of claims 7 to 14 wherein further ECG signals are derived using a predetermined transformation or set of transformations on the set comprised from, or a subset selected from, the second set of ECG signals and at least one synthesised temporary electrode signal.

20   16.   A method as claimed in any of claims 7 to 15 wherein at least one temporary electrode is located at any point on the right arm, shoulder or hand.

17.   A method as claimed in any of claims 7 to 16 wherein at least one temporary electrode is located at any point on the left arm, shoulder or hand.

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18.   A method as claimed in any of claims 7 to 17 wherein the temporary electrode(s) are connected at a different time from when the first set of ECG signals is acquired, or equivalently, activated temporarily, and the subject-specific transformations retrospectively calculated.

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19.   A method as claimed in any of claims 7 to 18 wherein a temporary electrode, after initial use, is used to perform functions other than that of supplying electrocardiogram signal data.

5   20.   The method of any of claims 7 to 19 wherein an input connection to a measurement means or device used to obtain a signal from an ECG electrode(s) has a secondary use to obtain a signal from a temporary electrode.

21.   The method of any preceding claim wherein the method includes switching an
10   electrode between separate modes of operation wherein in a first mode, the electrode measures an ECG signal and in a second mode, the electrode forms a reference electrical connection between a subject and an ECG measurement means.

22.   The method of any preceding claim further including the steps of:
15   applying a plurality of electrodes on a subject's body to enable the measurement of a set of ECG signals for that subject;
          detecting subject's body posture; and
          selecting or modifying the set of transformations on the basis of the subject's body posture.
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23.   The method of any preceding claim wherein the body posture is detected by an accelerometer, tilt sensor or manual switch.

24.   The method of any preceding claim, further including the steps of:
25   calculating a simulation matrix for at least one temporary signal from the first set of data or a subset thereof;
          applying a simulation matrix to the second set of ECG signals to generate a simulated temporary signal; and
          applying a fixed derivation matrix to the second data set plus the simulated
30   signal to define an unmeasured ECG lead; and
          adapting one or both of said matrices to compensate for subject specific variations in posture and movement.

25.   The method of claim 24 wherein the method of deriving unmeasured ECG signals comprises forming a matrix R which contains data points from the measured ECG signals, calculating a solution matrix A from the temporary electrode signals, and calculating a matrix sX using sX(i)=R*A(i).

26.   The method of claim 25 wherein a matrix M is formed from the first set of ECG signals plus the simulated temporary electrode signals, and further comprising forming a derived matrix dL(x)=M*B(x), where B(x) is a predetermined solution matrix and dL(x) simulates the data that would have been observed at an unmeasured electrode site.

27.   The method as claimed in any preceding claim wherein the method comprises measuring a first set of ECG signals, processing said signals to derive a standard 12 lead ECG and displaying said standard 12 lead ECG in real time.

28.   The method as claimed in any of claims 1 to 26 wherein the first set of ECG signals is recorded and stored for later processing to derive a standard 12 lead ECG.

29.   The method claimed in claim 28 further comprising displaying the derived standard 12 lead ECG signal.

30.   A method for obtaining a set of electrocardiographic (ECG) signals of the general type comprising synthesising ECG signals by receiving signals from a first group of electrodes connected to predetermined locations on a human body to acquire a first set of ECG signals and deriving at least one further ECG signal using predetermined transformation(s) on said first set of ECG signals or a subset thereof to form a desired set of signals, wherein said first group includes at least electrodes located at the following sites:

R and L: placed on or near the right and left upper limbs respectively; and

Vc: placed on the sternum.

31.   A method as claimed in claim 30 wherein sites R and L comprise specifically sites RC and LC placed at the same level as the manubrium on the right and left mid-clavicular lines respectively.

32.   A method as claimed in claim 30 wherein sites R and L comprise sites RA and LA placed on the right arm and left arm respectively.

33.   A method as claimed in any of claims 30 to 32 wherein site Vc is located on the sternum directly between the standard electrode sites V1 and V2.

34.   A method for obtaining a set of ECG signals of the general type comprising synthesising electrocardiographic (ECG) signals by receiving signals from a first group of electrodes connected to predetermined locations on a human body to acquire a first set of ECG signals and deriving at least one further ECG signal using predetermined transformation(s) on said first set of ECG signals or a subset thereof to form a desired set of signals, wherein said first group includes at least electrodes a located at the following sites:

Vm: one of the standard 12 lead electrode sites V4, V5 and V6 (m = 4, 5 or 6);

VnR: level with one of the standard electrode sites V4, V5 and V6 (n = 4, 5 or 6) on the right midclavicular line, right anterior auxiliary line or right midauxiliary line respectively; and

Vc: placed on the sternum.

35.   A method as claimed in claim 34 wherein m=n, so that VnR is opposite Vm and is therefore easier to place.

36.   A method as claimed in claim 35 wherein in a preferred embodiment, m=n=5, so that the sites Vm and VnR are V5 and V5R respectively.

37.   A method as claimed in claims 34, 35 or 36 wherein Vc is be located directly between the standard electrode sites V1 and V2.

38.   A method as claimed in any of claims 30 to 39 wherein at least five electrode sites are chosen.

39.   The method as claimed in any of claims 30 to 38 wherein the method includes

5   deriving an ECG signal from a temporary electrode that is not connected for the full duration the ECG measurement.

40.   A method for obtaining a set of electrocardiographic (ECG) signals by:

receiving signals from a first group of electrodes connected to predetermined

10   locations on a human body to acquire a first set of ECG signals;

synthesising   at   least   one   further   ECG   signal   using   predetermined transformation(s) on said first set of ECG signals or a subset thereof to form a synthesised set of ECG signals, each synthesised signal corresponding to a location on the body (hereinafter referred to as the synthesised location);

15   detecting the body's posture; and

selecting or modifying the transformations used in said synthesising step on the basis of the detected body posture, so as to reduce posture-induced inaccuracies between each synthesised signal and a real signal that would be measured at the synthesised location in a given posture.

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41.   The method of claim 40 wherein the body posture is detected using an accelerometer, tilt sensor or manual switch.

42.   An apparatus for synthesising ECG data comprising means arranged to receive

25   measured ECG signals and signal processing means arranged to perform the method steps according to any of claims 1-41.

43.   The apparatus as claimed in claim 42 wherein said signal processing means 15 arranged to implement a linear combination processing array for processing said

30   digitised signals to derive a standard 12 lead ECG.

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44.   An apparatus as claimed in claim 42 or 43 wherein said signal processing means is implemented using a general purpose microprocessor or digital signal processor circuit under software control.

5   45.   The apparatus as claimed in claim 42, 43 or 44 wherein the apparatus comprises separate units for processing and displaying ECG signals respectively, and means for interfacing the separate units for processing and displaying the ECG signals.

46.   A system for measuring ECG signals comprising a synthesising apparatus as 10   claimed in claim 42 in combination with means for storing signals from a subset of the group of electrodes, said synthesising apparatus being operable to process the stored signals from said subset of electrodes to obtain a standard 12 lead ECG.

47.   The system as claimed in claim 46 further comprising a set of leads 15   corresponding specifically to said subset of electrodes for obtaining said signals for storage and processing.

48.   The system as claimed in claim 46 or 47 wherein the means for storing said signal data includes a removable storage medium.

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49.   A storage device carrying program instructions for causing a general purpose microprocessor or digital signal processor circuit to implement a method as claimed in any of claims 1 to 41.